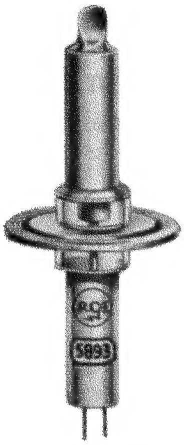
5893

UHF MEDIUM-MU TRIODE

"Pencil-Type" for Grounded-Grid Service

TENTATIVE DATA

RCA-5893 is a medium-mu triode of the "pencil-type" construction intended particularly for use in grounded-grid service as a plate-pulsed oscillator up to 3300 megacycles per second. In such service, it is capable of giving a useful peak power output of 1200 watts.



Actual Size

The 5893 may also be used as an rf power amplifier, cw oscillator, or frequency doubler up to 1000 megacycles per second particularly in low-power mobile transmitters. As an unmodulated class C rf power amplifier under ICAS conditions, this tube is capable of delivering a useful power output of approximately 6 watts at 1000 megacycles per second.

Featured in the 5893 is an improved "pencil-type" construction which not only meets requirements as to minimum transit time, low lead inductance, and low interelectrode capacitances, but also provides other desirable design features such as extreme sturdiness, small size, light weight, low heater wattage, good thermal stability, and convenience of use in equipment design. The tube has a length of only 2-5/16 inches and a diameter of only 1/4 inch exclusive of the grid flange.

The coaxial-electrode structure is of the double-ended metal-glass type in which the plate cylinder and cathode cylinder extend outward from each side of the grid flange. The latter is particularly effective in permitting isolation of the plate circuit from the cathode circuit in grounded-grid service. In addition, the disk-seal type of electrode termination, inherent in the design of "pencil-type" tubes, permits the utilization of closed-cavity resonators which minimize power loss through radiation, besides giving much lower inductance values and higher resonant frequencies than are obtainable with wire leads. Although designed for use in circuits of the coaxial-cylinder type, the 5893 is also suitable for use in circuits of the line type and lumped-circuit type.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC):		
Under Transmitting Conditions	6.0 ± 10%	volts
Under Standby Conditions	6.3 max.	volts
Current	0.330	ampere
Direct Interelectrode Capacitances (Approx.):		
Grid to Plate	1.75	μμf
Grid to Cathode	2.5	μμf
Plate to Cathode	0.07 max.	μμf

Characteristics, Class A_1 Amplifier:

Plate Voltage	200	volts
Cathode-Bias Resistor	100	ohms
Amplification Factor	27	
Plate Resistance	4500	ohms
Transconductance	6000	μmhos
Plate Current	25	ma

Mechanical:

Mounting Position	Any
Dimensions and Terminal Connections	See Outline Drawing
Plate Seal Temperature	175 max. °C

PLATE-PULSED OSCILLATOR▲ - Class C

Maximum Ratings, ***Absolute Values:***

For a maximum "on" time♦ of 5 microseconds

PEAK POSITIVE-PULSE PLATE-SUPPLY VOLTAGE♦	1750 max.	volts
PEAK NEGATIVE-PULSE GRID-BIAS VOLTAGE	150 max.	volts
PEAK PLATE CURRENT FROM PULSE SUPPLY	3 max.	amp
PEAK RECTIFIED GRID CURRENT	1.3 max.	amp
DC PLATE CURRENT	0.003 max.	amp
DC GRID CURRENT	0.0013 max.	amp
PLATE DISSIPATION⊕	6 max.	watts
PULSE DURATION	1.5 max.	μsec

Typical Operation with Rectangular Wave Shape in Grounded-Grid Circuit at 3300 Mc:

With duty factor⊕ of 0.001

Peak Positive-Pulse Plate-Supply Voltage♦	1750	volts
Peak Negative-Pulse Grid-Bias Voltage	110	volts
From Grid Resistor of	100	ohms
Peak Plate Current from Pulse Supply	3.0	amp
Peak Rectified Grid Current	1.1	amp
DC Plate Current	0.003	amp
DC Grid Current	0.0011	amp
Useful Power Output at Peak of Pulse§ (Approx.)	1200	watts
Pulse Duration	1.0	μsec
Pulse Repetition Rate	1000	pps

PLATE-MODULATED RF POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum Ratings, ***Absolute Values:***

	CCS●	*ICAS*●●	
DC PLATE VOLTAGE	260 max.	320 max.	volts
DC GRID VOLTAGE	-100 max.	-100 max.	volts
DC PLATE CURRENT	33 max.	33 max.	ma

	CCS●	ICAS●●	
DC GRID CURRENT.	15 max.	15 max.	ma
PLATE INPUT.	8.5 max.	10.5 max.	watts
PLATE DISSIPATION⊕	5 max.	5.5 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode . .	90 max.	90 max.	volts
Heater positive with respect to cathode . .	90 max.	90 max.	volts

Typical Operation in Grounded-Grid Circuit at 500 Mc:

DC Plate Voltage	250	300	volts
DC Grid Voltage▲	-36	-45	volts
DC Plate Current	30	30	ma
DC Grid Current (Approx.).	11	12	ma
Driver Power Output (Approx.) . . .	1.8	2.0	watts
Useful Power Output (Approx.) . . .	5.5	6.5	watts

Maximum Circuit Value:

Grid-Circuit Resistance. .	0.1 max.	0.1 max.	megohm

RF POWER AMPLIFIER AND OSCILLATOR - Class C Telegraphy

Key down conditions per tube without amplitude modulation★

Maximum Ratings, ***Absolute Values:***

	CCS●	ICAS●●	
DC PLATE VOLTAGE	320 max.	400 max.	volts
DC GRID VOLTAGE.	-100 max.	-100 max.	volts
DC PLATE CURRENT	35 max.	40 max.	ma
DC GRID CURRENT.	15 max.	15 max.	ma
PLATE INPUT.	11 max.	16 max.	watts
PLATE DISSIPATION⊕	7 max.	8 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode . .	90 max.	90 max.	volts
Heater positive with respect to cathode . .	90 max.	90 max.	volts

Typical Operation as RF Power Amplifier in Grounded-Grid Circuit at 500 Mc:

DC Plate Voltage	300	350	volts
DC Grid Voltage†	-47	-51	volts
DC Plate Current	33	35	ma
DC Grid Current (Approx.).	13	13	ma
Driver Power Output (Approx.) . . .	2	2.5	watts
Useful Power Output (Approx.) . . .	7.5	8.5	watts

Typical Operation as RF Power Amplifier in Grounded-Grid Circuit at 1000 Mc:

DC Plate Voltage	300	350	volts
DC Grid Voltage†	-30	-33	volts
DC Plate Current	33	35	ma
DC Grid Current (Approx.).	12	13	ma
Driver Power Output (Approx.) . . .	1.9	2.4	watts
Useful Power Output (Approx.) . . .	5.5	6.5	watts

Typical Operation as Oscillator in Grounded-Grid Circuit at 500 Mc:

DC Plate Voltage	300	350	volts
DC Grid Voltage†	-47	-51	volts
DC Plate Current	33	35	ma
DC Grid Current (Approx.).	13	13	ma
Useful Power Output (Approx.) . . .	5	6	watts

Maximum Circuit Value:

Grid-Circuit Resistance. .	0.1 max.	0.1 max.	megohm

FREQUENCY DOUBLER

Maximum Ratings, ***Absolute Values:***

	CCS●	ICAS●●	
DC PLATE VOLTAGE	260 max.	320 max.	volts
DC GRID VOLTAGE.	-100 max.	-100 max.	volts
DC PLATE CURRENT	33 max.	33 max.	ma
DC GRID CURRENT.	12 max.	12 max.	ma
PLATE INPUT.	8.5 max.	10.5 max.	watts
PLATE DISSIPATION⊕	6 max.	7.5 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode . .	90 max.	90 max.	volts
Heater positive with respect to cathode . .	90 max.	90 max.	volts

Typical Operation as Doubler to 1000 Mc in Grounded-Grid Circuit:

DC Plate Voltage	250	300	volts
DC Grid Voltage†	-40	-50	volts
DC Plate Current	33	33	ma
DC Grid Current (Approx.).	7	8	ma
Driver Power Output (Approx.) . . .	3.2	3.5	watts
Useful Power Output (Approx.) . . .	2.75	3.0	watts

Maximum Circuit Value:

Grid-Circuit Resistance. .	0.1 max.	0.1 max.	megohm

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current	1	0.3	0.36	amp
Grid-to-Plate Capacitance.	-	1.45	2.05	μμf
Grid-to-Cathode Capacitance	-	2.05	2.95	μμf
Plate-to-Cathode Capacitance	-	-	0.07	μμf
Plate Current.	1,2	16	34	ma
Useful Power Output at Peak of Pulse	1,3	750	-	watts

Note 1: With 6.0 volts ac or dc on heater.

Note 2: With dc plate voltage of 200 volts and cathode resistor of 100 ± 1% ohms.

Note 3: With peak positive-pulse plate-supply voltage of 1750 volts, grid resistor varied to give dc plate current of 3 ma, dc grid current of approximately 1.1 ma, duty factor of 0.001, and frequency of 3300 Mc.

● Continuous Commercial Service.

●● Intermittent Commercial and Amateur Service.

▲ In this class of service, the heater should be allowed to warm up for a minimum of 60 seconds before plate voltage is applied.

⊕ In applications where the plate dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the plate cylinder and the connector in order to provide adequate heat conduction.

♁ "On" time for this tube is the sum of the durations of all the individual pulses which occur during any 5000-microsecond interval. Pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

⧫ The magnitude of any spike on the plate voltage pulse should not exceed a value of 2000 volts with respect to cathode and its duration should not exceed 0.01 microsecond measured at the peak-pulse-value level.

✠ Duty factor is the product of pulse duration and repetition rate. For variable pulse durations and pulse repetition rates, the duty factor is defined as the ratio of time "on" to total elapsed time in any 5000-microsecond interval.

§ The power output at peak of pulse is obtained from the average power output using the duty factor of the peak pulse. This procedure is necessary since the power output pulse duty factor may be less than the applied voltage pulse duty factor because of a delay in the start of rf power output.

† Obtained from grid resistor.

★ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

OPERATING CONSIDERATIONS

The *maximum ratings* are limiting values above which the serviceability of the 5893 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of the rating by an amount such that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

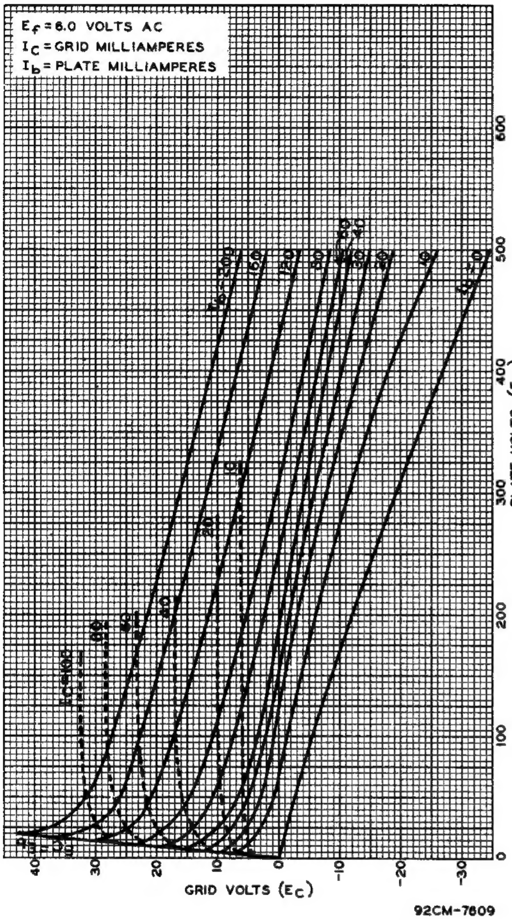


Fig. 1 - Average Constant-Current Characteristics of Type 5893.

The *temperature* of the plate seal should not exceed 175 degrees centigrade (at the hottest point). The temperature may be measured with temperature sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y. in the form of liquid and stick, and is stated by the manufacturer to have an accuracy of one per cent.

Connections to the cathode cylinder, grid flange, and plate cylinder should be made by flexible spring contacts only. The connectors must make firm, large-surface contact, yet must be sufficiently flexible so that no part of the tube is subjected to strain. Unless this recommendation is observed, the glass-to-metal seals may be damaged.

The *heater* leads of the 5893 fit the Cinch socket No. 54A11953. They should not be soldered to circuit elements. The heat of the soldering operation may crack the glass seals of the heater leads and damage the tube.

The *cathode* should preferably be connected to one side of the heater. When, in some circuit designs, the heater is not connected directly to the cathode, precautions must be taken to hold the peak heater-cathode voltage to the maximum values shown in the tabulated data.

In *grounded-grid plate-pulsed oscillator service*, the 5893 should be supplied with bias from a grid resistor. In such service, if the pulse is applied to the plate through a pulse transformer, it is necessary that the contact-potential current in the plate and grid circuits (which can be measured while the modulator is off) be subtracted from the dc plate and grid currents measured during operation in order to obtain the value of plate current for measuring peak plate current and power input. For example, the average contact-potential currents are approximately 0.4 milliampere dc in the plate circuit and 1 milliampere dc in the grid circuit. The value in the grid circuit will vary to some extent with the grid-circuit impedance. A plate current reading of 3 milliamperes during the pulse would, therefore, be corrected to 2.6 milliamperes for use in determining the peak power input.

In *plate-modulated class C rf power amplifier service*, the 5893 should be supplied with bias from a grid resistor, or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor. The cathode resistor should be bypassed for both audio and radio frequencies. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation. Grid-bias voltage is not particularly critical so that correct adjustment may be obtained with values differing widely from the calculated values.

In *grounded-grid plate-modulated class C telephony service*, the 5893 can be modulated 100 per cent if the rf driver stage is also modulated 100 per cent simultaneously. Care should be taken to insure that the driver-modulation and the amplifier-modulation voltages are exactly in phase. In such service, the 5893 requires increased driving power, but increased power output is obtained as shown in the tabulated data.

In *class C rf telegraphy service*, the 5893 may be supplied with bias by any convenient method. When the tube is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to limit the plate current and, therefore, the plate dissipation to a safe value. If the 5893 is operated at a plate voltage of 300 volts, a fixed bias of at least -10 volts should be used.

This effect will be noticed by the simultaneous increase in plate currents of both the output and driving stages.

Push-pull or parallel circuit arrangements may be used when more radio-frequency power is required than can be obtained from a single tube. Two tubes in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube. With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. When two or more tubes are used in the circuit, precautions should be taken to balance the plate currents.

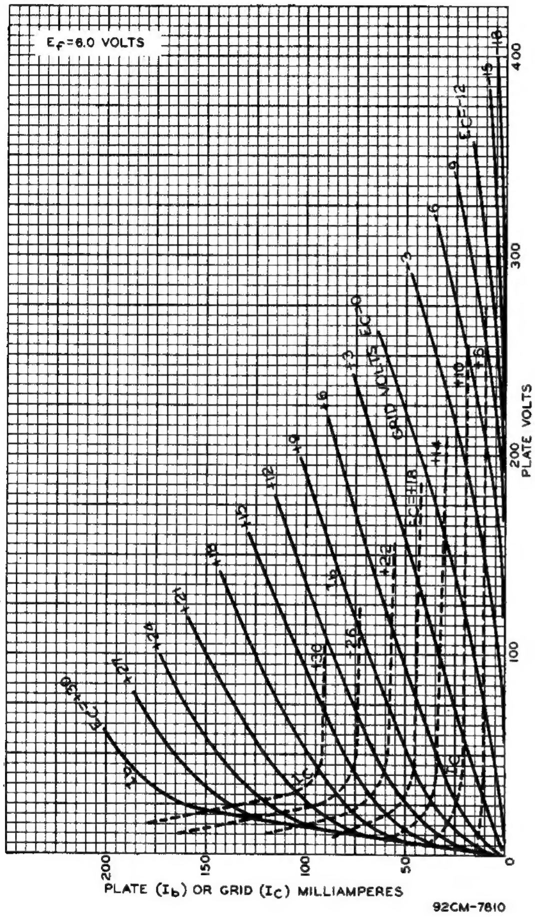


Fig. 2 - Average Plate Characteristics of Type 5893.

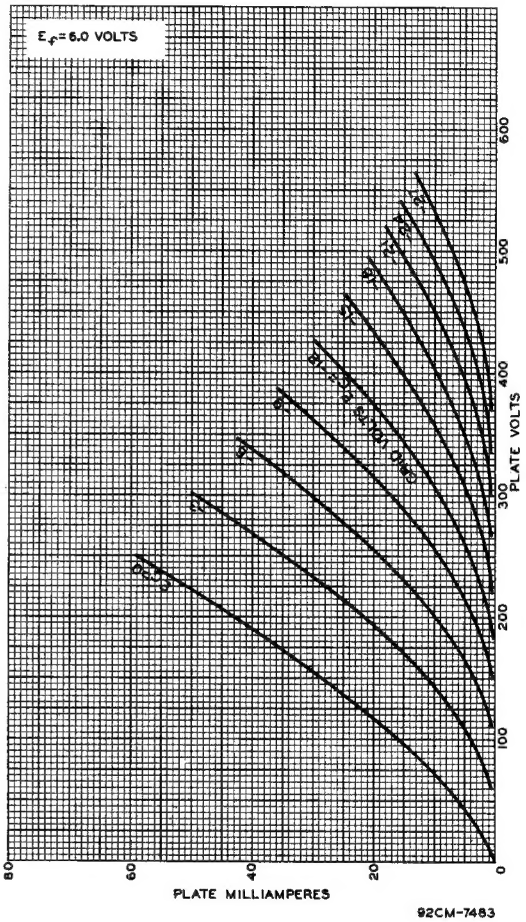


Fig. 3 - Average Plate Characteristics of Type 5893.

In *grounded-grid circuits*, the grid-driving voltage and the developed rf plate voltage act in series to supply the load circuit. As a result, the required driving power is increased over that needed for grounded-cathode circuits. The increased driving power is not lost because it appears as output from the grounded-grid stage. If the driving voltage and grid current are increased, the output will always increase.

In tuning a grounded-grid rf amplifier, it must be remembered that variations in the load on the output stage will produce corresponding variations in the load on the driving stage.

REFERENCES

G.M. Rose, D.W. Power, and W.A. Harris, *"Pencil-Type UHF Triodes"*, RCA Review, Vol. 10, No. 3, pp. 321-338 (September, 1949).

E.E. Spitzer, *"Grounded-Grid Power Amplifiers"*, Electronics, Vol. 19, No. 4, pp. 138-141 (April, 1946).

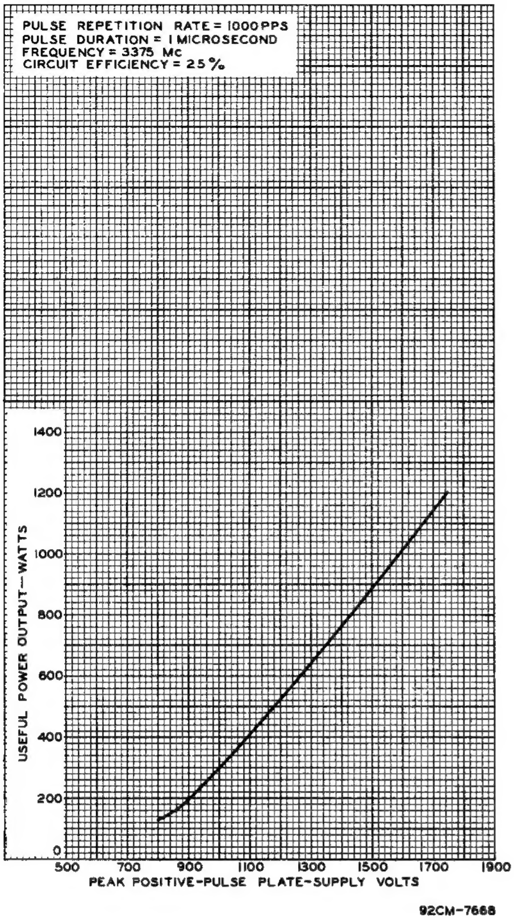
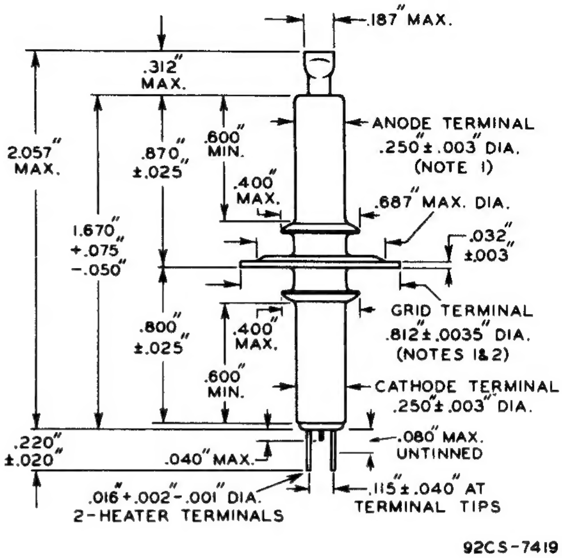


Fig. 4 - Average Performance Characteristic of Type 5893.

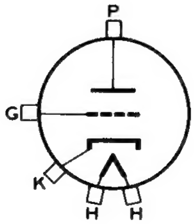
DIMENSIONAL OUTLINE



NOTE 1: MAX. ECCENTRICITY OF ℄ (AXIS) OF ANODE TERMINAL OR GRID-TERMINAL FLANGE WITH RESPECT TO THE ℄ (AXIS) OF THE CATHODE TERMINAL IS 0.008".

NOTE 2: TILT OF GRID-TERMINAL FLANGE WITH RESPECT TO ROTATIONAL AXIS OF CATHODE TERMINAL IS DETERMINED BY CHUCKING THE CATHODE TERMINAL, ROTATING THE TUBE, AND GAUGING THE TOTAL TRAVEL DISTANCE OF THE GRID-TERMINAL FLANGE PARALLEL TO THE AXIS AT A POINT APPROXIMATELY 0.020" INWARD FROM ITS EDGE FOR ONE COMPLETE ROTATION. THE TOTAL TRAVEL DISTANCE WILL NOT EXCEED 0.020".

TERMINAL CONNECTIONS



H: HEATER
K: CATHODE
G: GRID
P: PLATE